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ABSTRACT

This paper is designed to help educators to incorporate the competencies developed by the Secretary's Commission on Achieving Necessary Skills (SCANS) into their curricula. (SCANS is a commission composed of representatives of education, business, labor, and state government established in 1990 to define a common core of skills that constitute job readiness.) The paper suggests how to approach issues that schools will have to resolve before the competencies can be taught, such as where in the curriculum they should be introduced and how learning objectives can be developed. Specific examples of teaching individual competencies are included for the five SCANS competencies: resources; information; interpersonal; systems; and technology. The following three exhibits are included: (1) definitions for the five SCANS competencies, with examples of tasks or performances that illustrate the use of each skill; (2) a matrix showing how each subject-matter area can be used to develop each competency; and (3) examples of teaching competencies at different developmental levels. A resources section contains 50 references, most of which relate to a specific competency. (KC)

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THE SECRETARY'S COMMISSION ON ACHIEVING NECESSARY SKILLS

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SCANS In The Schools

Carol E. Copple
Michael Kane
Nancy S. Matheson
Ann S. Meltzer
Arnold Packer
Thomas G. White

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EMPLOYMENT AND TRAINING ADMINISTRATION
Roberts T. Jones, Assistant Secretary of Labor

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Arnold H. Packer, Executive Director

RESEARCH CONTRACTOR'S CORE TEAM
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Norman Peterson
Roselda Henry
Nancy Matheson
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Gary D. Watts, National Education Association

Sharyn Marr Wetjen, High School Redirection

Gerald Whitburn, Wisconsin Department of Health and Social Services

John H. Zimmerman, MCI Communications

ABOUT THE AUTHORS

Carol E. Copple is a Senior Research Analyst at Pelavin Associates, Inc. Dr. Copple has been actively involved in classroom teaching, curriculum development, educational research, and teacher training. She has also had wide-ranging experience writing about education for parents, teachers, policy-makers, and the general public.

Michael Kane, a Principal of Pelavin Associates, Inc., led the multi-firm team that provided technical and research support to the Secretary's Commission on Achieving Necessary Skills (SCANS). In addition to this assignment, Dr. Kane has managed a variety of educational research and evaluation projects and has served in senior management roles in federal and state education agencies. He has also served as both executive director and chairperson of state education reform commissions.

Nancy S. Matheson is a Research Analyst at Pelavin Associates, Inc. She was a senior researcher for the SCANS technical assistance contract and was actively involved in the field research that supported the SCANS commission. Dr. Matheson has conducted research and published articles and book chapters on employment-related issues, including employee work attitudes and adult learning.

Ann S. Meltzer, a Senior Research Analyst with Pelavin Associates, Inc., was Deputy Project Director for the SCANS support contract. Ms. Meltzer also served as Project Director of Pelavin Associates' study for DOL of the upgrade training of employed workers. Prior to this, Ms. Meltzer worked for the American Society of Training and Development where she co-authored the book and manual, Workplace Basics: The Essential Skills Employers Want.

Arnold Packer served as Executive Director of SCANS. Prior to assuming this role he was the Deputy Director of the Work Force 2000 study at the Hudson Institute and co-author of *WorkForce 2000: Work and Workers for the 21st Century*, a seminal report that has had a wide-ranging impact on human resource policy in government and in the private sector.

Thomas G. White recently joined Pelavin Associates as a Senior Research Analyst. Dr. White has taught at the college and middle school level and worked as an educational researcher, program evaluator, and curriculum developer. His articles have appeared in both scholarly and practitioner-oriented journals, including *The Reading Teacher, Reading Research Quarterly, Journal of Experimental Child Psychology,* and *Journal of Educational Psychology.*

PREFACE

Our economy and the world of work are changing rapidly. New technologies and services are appearing overnight; jobs and their skill requirements are constantly changing; and the United States faces fiercer economic competition than ever from abroad.

The Secretary's Commission on Achieving Necessary Skills (SCANS), composed of representatives of education, business, labor, and state government, was established in 1990 and charged with defining a common core of skills that constitute job readiness in this new economic environment.

During the course of its work, SCANS produced several publications, three of which are referred to in this paper: the Commission's first report, *What Work Requires of Schools*, sets forth the foundation skills and workplace competencies—the workplace know-how—that high-performance workplaces require and that high-performance schools should produce; *Skills and Tasks for Jobs* describes how SCANS competencies and skills are used in 50 occupations; and *Learning a Living: A Blueprint for High Performance*, the Commission's final report, calls for a reorganization of education and work to close the skills gap and prepare the workforce for the future.

The foundation skills identified in *What Work Requires of Schools* are the basic literacy and computational skills, the thinking skills necessary to put knowledge to work, and the personal qualities that make workers dedicated and trustworthy. The competencies are the ability to manage resources, to work amicably and productively with others, to acquire and use information, to master complex systems, and to work with a variety of technologies.

For many if not most schools, teaching the SCANS competencies will require a sharp departure from traditional practice, a departure that will be especially challenging due to a lack of professional development in this area, relevant supporting materials, and successful school models. This document, "SCANS in the Schools," provides assistance to educators who want to put the SCANS know-how to work in their classrooms now. It is the first in a series of papers that will be published later this year in a single volume entitled *Teaching the SCANS Competencies*.

"SCANS in the Schools" was prepared by the staff of Pelavin Associates, the SCANS research contractor. The paper is designed for educators planning to incorporate the teaching of SCANS competencies in their curriculum and instruction. It suggests how to approach issues that will have to be dealt with before schools will be able to teach students the competencies. Where in the curriculum will they be taught—should resource allocation be taught in 10th grade mathematics or 12th grade geography or both? What are the key dimensions of each competency from which teachers and curriculum developers can derive learning objectives?

Specific examples of how individual competencies can be taught are included. Products and resources are also referenced. These are provided to show the potential of available educational software and other materials for promoting information skills and other abilities needed in the workplace, not as an endorsement of any particular products over others.

In addition, the paper includes a bibliography designed to serve as a resource for educators and researchers interested in workforce development issues. The authors hope that the information and materials included in this paper will make it possible for concerned and creative educators to begin their response to the SCANS message and provide their students with the tools they need to succeed in the modern workplace.

SCANS IN THE SCHOOLS

INTRODUCTION

This paper addresses the question: How will schools enable students to acquire the SCANS skills? The specific shape and substance of SCANS implementation will vary, of course, from school to school. But it is important to lay out the key dimensions within each SCANS competency, specify what students need to learn, and consider where in the curriculum the skills will be taught. We will also take a look at some of the innovative methods educators are beginning to use to help students acquire necessary skills within each competency.

Exhibit 1 provides the definitions for the five SCANS competencies—resources, information, interpersonal, systems, and technology. It also includes examples of tasks or performances that illustrate the use of each skill. Before examining each of the competencies in turn, let us consider a few general points about integrating SCANS into the curriculum.

One of the first questions principals, teachers, curriculum developers, and parents will ask is "Where?"—**Where within the curriculum will SCANS be taught?** Are educators to develop new courses—SCANS 101—or incorporate the learning of SCANS skills into existing courses?

Although a new course or two might be designed at some schools (Principles of Technology, for instance), the primary place to teach SCANS skills is within the existing curriculum. SCANS skills can and should be integrated into each subject in the core curriculum. The matrix displayed in Exhibit 2 illustrates how each subject-matter area can be used to develop each competency.

The skills identified by SCANS as necessary for work are already taught to a limited extent in existing courses. For instance, students may learn about ecological systems in a science class. But even when such knowledge is embedded in the current curriculum, it typically is not made "intellectually explicit." In addition, teachers and students are not connecting a particular isolated piece of knowledge (the forest as an ecological system) to the broader competency (learning how systems function). When such connections are not made explicit, students are less likely to generalize skills and knowledge and apply them in new situations.

It is important, in particular, to connect knowledge and skills to workplace applications so students can see how they will use them. Creating such connections leads to the "How?" question: **How are SCANS skills best taught and learned?** Do we need different instructional methods as well as different curricula?

Chapter 4 of the SCANS report *Learning a Living: A Blueprint for High Performance* outlines the instructional implications of SCANS. A major emphasis is teaching skills "in context." This means placing learning objectives within real environments rather than insisting that students first learn in the abstract what they will later be expected to apply. Teaching in

EXHIBIT 1

Definitions: The Competencies

RESOURCES

Allocates Time. Selects relevant, goal-related activities, ranks them in order of importance, allocates time to activities, and understands, prepares, and follows schedules.

Examples:
- construct a timeline chart, e.g., Gantt, PERT;
- understand the concept of a critical path;
- estimate the time required to complete a project by task; or
- use computer software, e.g., Harvard Project Planner, to plan a project.

Allocates Money. Uses or prepares budgets, including cost and revenue forecasts; keeps detailed records to track budget performance; and makes appropriate adjustments.

Examples:
- estimate costs;
- prepare a multi-year budget using a spreadsheet; or
- do a cost analysis.

Allocates Material and Facility Resources. Acquires, stores, and distributes materials, supplies, parts, equipment, space, or final products in order to make the best use of them.

Examples:
- lay out a workspace document with narrative and graphics using desktop publishing software;
- demonstrate understanding of First In First Out (FIFO) and Just in Time (JIT) inventory systems; or
- design a request for proposal (RFP) process.

Allocates Human Resources. Assesses knowledge and skills and distributes work accordingly, evaluates performance, and provides feedback.

Examples:
- develop a staffing plan;
- write a job description; or
- conduct a performance evaluation.

EXHIBIT 1 (Continued)

Definitions: The Competencies

INFORMATION

Acquires and Evaluates Information. Identifies need for data, obtains it from existing sources or creates it, and evaluates its relevance and accuracy.

Examples:

- develop a form to collect data;
- research and collect data from appropriate sources (library, on-line data bases, field research); or
- develop validation instrument for determining accuracy of data collected.

Organizes and Maintains Information. Organizes, processes, and maintains written or computerized records and other forms of information in a systematic fashion.

Examples:

- develop a filing system for storing information (printed or computerized);
- develop an inventory record-keeping system; or
- develop a bill processing system.

Interprets and Communicates Information. Selects and analyzes information and communicates the results to others using oral, written, graphic, pictorial, or multi-media methods.

Examples:

- produce a report using graphics to interpret and illustrate associated narrative information;
- make an oral presentation using several different media to present information (overheads, slides, film, audio); or
- develop material for communicating information to be used during a teleconference call.

EXHIBIT 1 (Continued)

Definitions: The Competencies

Uses Computers to Process Information. Employs computers to acquire, organize, analyze, and communicate information.

Examples:
- use a computer spreadsheet, e.g., Lotus 1-2-3, to develop a budget;
- use a computer graphics program, e.g., Harvard Graphics, to prepare overheads for a report; or
- use on-line computer data bases, e.g., Lexus, New York Times, ERIC, to research a report.

INTERPERSONAL

Participates as a Member of a Team. Works cooperatively with others and contributes to group with ideas, suggestions, and effort.

Examples:
- collaborate with group members to solve a problem;
- develop strategies for accomplishing team objectives; or
- work through a group conflict situation.

Teaches Others. Helps others learn.

Examples:
- train a colleague on-the-job; or
- explore possible solutions to a problem in a formal group situation.

Serves Clients/Customers. Works and communicates with clients and customers to satisfy their expectations.

Examples:
- demonstrate an understanding of who the customer is in a work situation;
- deal with a dissatisfied customer in person; or
- respond to a telephone complaint about a product.

EXHIBIT 1 (Continued)

Definitions: The Competencies

Exercises Leadership. Communicates thoughts, feelings, and ideas to justify a position; and encourages, persuades, convinces, or otherwise motivates an individual or group, including responsibly challenging existing procedures, policies, or authority.

Examples:
- use specific team-building concepts to develop a work group;
- select and use an appropriate leadership style for different situations; or
- use effective delegation techniques.

Negotiates. Works towards an agreement that may involve exchanging specific resources or resolving divergent interests.

Examples:
- develop an action plan for negotiating;
- write strategies for negotiating; or
- conduct an individual and a team negotiation.

Works with Cultural Diversity. Works well with men and women and with a variety of ethnic, social, or educational backgrounds.

Examples:
- demonstrate an understanding of how people with differing cultural/ethnic backgrounds behave in various situations (work, public places, social gatherings); or
- demonstrate the use of positive techniques for resolving cultural/ethnic problem situations.

SYSTEMS

Understands Systems. Knows how social, organizational, and technological systems work and operate effectively within them.

Examples:
- draw and interpret an organizational chart;
- develop a chart that illustrates an understanding of stocks and flows; or
- draw a diagram that illustrates a technological problem definition and problem-solving process.

EXHIBIT 1 (Continued)

Definitions: The Competencies

Monitors and Corrects Performance. Distinguishes trends, predicts impact of actions on system operations, diagnoses deviations in the function of a system/organization, and takes necessary action to correct performance.

Examples:
- generate a statistical process control (SPC) chart;
- develop a forecasting model; or
- develop a monitoring process.

Improves and Designs Systems. Makes suggestions to modify existing systems to improve products or services, and develops new or alternative systems.

Examples:
- draw a diagram showing an improved organizational system based on Deming's 14 points; or
- choose a situation needing improvement, break it down, examine it, propose an improvement, and implement it.

TECHNOLOGY

Selects Technology. Judges which set of procedures, tools, or machines, including computers and their programs, will produce the desired results.

Example:
- read equipment descriptions and technical specifications to select equipment to meet needs.

Applies Technology to Task. Understands the overall intent and the proper procedures for setting up and operating machines, including computers and their programming systems.

Example:
- set up/assemble appropriate equipment from instructions.

Maintains and Troubleshoots Technology. Prevents, identifies, or solves problems in machines, computers, and other technologies.

Examples:
- read and follow instructions for troubleshooting and repairing relevant equipment; or
- read and follow maintenance instructions for keeping relevant equipment in good working order.

EXHIBIT 2

Assignments That Integrate The SCANS Competencies Into The Core Curriculum Areas

	CURRICULUM AREA				
Competency	**English/Writing**	**Mathematics**	**Science**	**Social Studies/Geography**	**History**
Resources	Write a proposal for an after-school career lecture series that schedules speakers, coordinates audio-visual aids, and estimates costs.	Develop a monthly family budget, taking into account family expenses and revenues and using information from the budget plan, schedule a vacation trip that stays within the resources available.	Plan the material and time requirements for a chemistry experiment, to be performed over a two-day period, that demonstrates a natural growth process in terms of resource needs.	Design a chart of resource needs for a community of African Zulus. Analyze the reasons why three major cities grew to their current size.	Study the Vietnam War, researching and orally presenting findings on the timing and logistics of transporting materials and troops to Vietnam and on the impact of the war on the Federal budget.
Interpersonal	Discuss the pros and cons of the argument that Shakespeare's *Merchant of Venice* is a "racist" play and should be banned from the school curriculum.	Present the results of a survey to the class, and justify the use of specific statistics to analyze and represent the data.	Work in a group to design an experiment to analyze the lead content in the school's water. Teach the results to an elementary school class.	Debate the issue of withdrawing U.S. military support from Japan in front of a peer panel. Engage in a mock urban planning exercise for Paris.	Study the American Constitution and role-play the negotiation of the wording of the free states/slave states clause by different signers.
Information	Identify and abstract passages from a novel to support an assertion about the values of a key character.	Design and carry out a survey and analyze the data in a spreadsheet program using algebraic formulas. Develop a table and a graphic display to communicate the results.	In an entrepreneurship project, present statistical data pertaining to a high-tech company's production and sales. Use a computer to develop the statistical charts.	Using numerical data and charts, develop and present conclusions about the effects of economic conditions on the quality of life in several countries.	Research and present papers on the effect of the Industrial Revolution on the class structure in Britain, citing data sources used to arrive at conclusions.

EXHIBIT 2 (Continued)

Assignments That Integrate The SCANS Competencies Into The Core Curriculum Areas

	CURRICULUM AREA				
Competency	**English/Writing**	**Mathematics**	**Science**	**Social Studies/Geography**	**History**
Systems	Develop a computer model that analyzes the motivation of Shakespeare's *Hamlet.* Plot the events that increase or decrease Hamlet's motivation to avenge the death of his father by killing Claudius.	Develop a system to monitor and correct the heating/cooling process in a computer laboratory, using principles of statistical process control.	Build a model of human population growth that includes the impact of the amount of food available, on birth and death rates, etc. Do the same for a growth model for insects.	Analyze the accumulation of capital in industrialized nations in systems terms (as a reinforcing process with stocks and flows).	Develop a model of the social forces that led to the American Revolution. Then explore the fit between that model and other revolutions.
Technology	Write an article showing the relationship between technology and the environment. Use word processing to write and edit papers after receiving teacher feedback.	Read manuals for several data-processing programs and write a memo recommending the best programs to handle a series of mathematical situations.	Calibrate a scale to weigh accurate portions of chemicals for an experiment. Trace the development of this technology from earliest uses to today.	Research and report on the development and functions of the seismograph and its role in earthquake prediction and detection.	Analyze the effects of wars on technological development. Use computer graphics to plot the relationship of the country's economic growth to periods of peace and war.

context implies that schools will provide students with the opportunities to apply knowledge in real-life situations or simulations, e.g., problems or projects related to workplace situations, as well as internships, mentorships, and "shadowing" workers on the job.

Along with the SCANS emphasis on learning in context is the focus on students becoming more active in their own learning. In the view of the Commission, students do not learn to grapple with problems and to apply skills if teachers are always directing the learning and doing the talking. Working together on problems, students are more responsible for their own learning, more actively involved. Most importantly, they are functioning as they will in the workplace.

Integrating All the SCANS Competencies

In the workplace, we do not use one skill at a time in isolation from other skills; effective performance requires many different skills used in combination. It stands to reason, then, that students benefit from working on tasks and problems that call on a range of skills. Here's an example (adapted from a chemistry class in the Fort Worth Independent School District).

> A high school chemistry teacher gave his students a problem: to determine the best lawn fertilizer for the school to use. Students worked together in small groups, and each group tackled the problem in its own way. They designed experiments to investigate the effects of fertilizers differing in chemical composition. When they needed more information, they called on experts from industry or academia. Their recommendations were not based only on applying chemistry and using scientific methods; they also had to weigh costs and other feasibility factors. Once they reached conclusions, students had to develop reports, including charts and computer graphics, which would present their conclusions and persuade school decision-makers to accept their recommendations. They studied how such decisions are made within the institution, determined how to inform and convince key players, and participated in the negotiation process.

Clearly, such a project develops skills within the five SCANS competencies of resources, interpersonal, information, systems, and technology. Teachers with different skills and/or subject-matter expertise (writing, computer graphics, etc.) will probably participate at various junctures, along with experts from the community. Working on such a project, students acquire and practice skills in ways they will actually use them on the job; they use many skills in combination, and all skills are directed toward a purpose.

This project, it should be noted, is not based on a problem neatly defined in advance with an answer that the teacher knows and the students must arrive at. New complexities and side issues arise as the students wade into the problem—like the problems adults encounter in real jobs.

Moreover, there are real-world outcomes of students' work. The soundness of the students' research, the degree to which they consider the full range of relevant factors, the cogency with which they present their recommendations, and the savvy with which they deal with the powers-that-be will determine whether their recommendations are accepted. The motivation to perform each task well does not rest solely on a grade but is intrinsic to the enterprise—the

better a task is carried out, the more likely a successful final outcome. These elements are all important for effective education.

SCANS in the K-12 Curriculum

The details of what to teach at the elementary, middle school, and secondary levels (as well as in postsecondary settings) will need to be worked out for each competency and will take much careful thought and experimentation by teachers and curriculum developers. This introduction simply offers a few generalizations about the developmental progression in teaching SCANS-related skills and knowledge and ends by offering an example of how one set of skills, acquiring and using information, might be taught in elementary, middle, and secondary school levels.

In considering the timing for introducing SCANS skills, one rule of thumb is that students should not specialize too early, that is, pursue a specific occupation or field to the exclusion of others. Rather, **all students should begin by developing the fundamental conceptual foundation and skills that will allow them to acquire more specialized skills later on.** From the beginning, instruction in this conceptual foundation should be integrated with the core subject areas.

In a model dropout prevention program designed by the National Academy Foundation, for instance, eleventh graders may opt to enter one of the specialized programs designed to prepare them for a specific field (e.g., finance, travel and tourism, public affairs), but up through tenth grade they acquire skills applicable in all occupations and jobs. In the interpersonal area, for instance, they learn to participate in a group, assess group effectiveness, give and receive constructive criticism, and teach others new skills. These "generic" skills—useful and important in every field and job—belong in every student's course of study and should precede instruction in more specialized skills.

This observation leads to the next key point about sequences of instruction. Students usually do not acquire Skill A only at a single point in time—for example, learn the skill of participating in a group in fourth grade—and then move on to other skills. Rather, they keep developing group participation skills—or any set of skills—at **successively more advanced levels.** The model is that of a spiral, with each competency developed throughout the K-12 curriculum. Exhibit 3 illustrates how this works. Students in the elementary grades have a range of experiences with developing data forms, such as the one described, that gives them the sense that they can develop forms to serve their purposes and shows them how to go about doing this. By middle school, their experience base, as well as their higher stage of cognitive development, allows them to tackle more complex and advanced tasks in gathering and presenting data. Still more sophisticated tasks and procedures, such as sampling, are introduced at the high school level. Spirals of this kind—with a greater number and complexity of skills drawn into learning activities at higher grade levels—can be designed for any set of skills within the SCANS competencies. The factors noted under "Developmental Considerations" in Exhibit 3 are not exhaustive lists of all aspects of development that educators will need to consider; they only illustrate the kinds of developmental issues that arise in planning a coherent curriculum across the K-12 span.

EXHIBIT 3

Teaching A Given Competency At Different Developmental Levels

Competency: Acquiring and Using Information, particularly **developing a form to collect data, presenting results with charts and tables,** and **using a computer** to create the form and to present data.

[Grades K-3] In planning for Family Night at the school, a team of second graders determines that it needs to know how many adults and children of various ages are planning to attend. The teacher suggests that team members develop a simple form to circulate in order for classmates to indicate who in their families will be coming. They also write simple instructions. From classmates' questions, the team sees a point that needs to be clarified in the instructions and makes the necessary revision.

What's Developed in This Activity

- Awareness of the usefulness of a form in gathering information.
- Direct experience of the fact that a form will not serve its purpose if it is not clear to respondents what information they are being asked to supply.
- Recognition of the value of "pilot testing" a form with a group before making it final.

Developmental Considerations

In designing the activity for this age group, the teacher needs to take into account developmental considerations such as:

- The purpose of the task must be clear and meaningful to students. While important at all levels, this is especially critical with younger students because they have limited experience with forms. They need to get a clear sense that forms are devised to help gather information in an efficient way.
- The task must not be too complex. There should be only a few factors to take into account, and the nature of the information being gathered should be straightforward and familiar to the children (e.g., the number of parents who are planning to come). In addition, the "technology" used to produce the form (in this case writing it by hand) should not be so demanding that students are unable to focus on planning the form itself.
- Feedback to students (from trying out the form) should occur as soon as possible after they finish their product. Young children's interest and motivation will diminish if there is too much delay between task completion and feedback.

EXHIBIT 3 (Continued)

Teaching A Given Competency At Different Developmental Levels

[Grades 7-8] In discussing public opinion polls with a social studies class, the teacher asks the students to develop their own survey of class opinion. They choose an issue of interest to them: the rating system for movies (R, PG-13, etc.). Each class member writes three potential questions for the survey, and one group of students works out an efficient system for compiling these as a starting point for developing the survey form. Another student group has the job of selecting and editing the questions and laying out the survey form, using word processing software that group members have used before in writing activities but not in producing forms. When these students are debating whether to ask "Do you think the rating system is censorship?" or "Do you think the rating system is wrong?" the teacher suggests they produce two versions of the form and try each on half the students (and, indeed, they get different results). A third group tallies the number of "Yes," "No," and "Undecided" responses to each question and (with calculators) converts these results into percents. A fourth group looks at how magazines and newspapers display public opinion results, decides to use pie and bar charts, produces them, and gets class reactions to the two ways of displaying the data.

What's Developed in This Activity

Among the many skills developed in this activity, two are closely related to competence in gathering and presenting information:

- Awareness of how differences in forms (e.g., changes in wording) can change results.
- Familiarity with the various ways of presenting survey information and the advantages and disadvantages of each.

Developmental Considerations

- Middle school students can understand the difference between opinion and fact and recognize what is involved in gathering either.
- Understanding that changing the wording of a question can change reported opinion, is well within the grasp of these students, and is an important concept for them to bear in mind in acquiring information from others.
- Analyses and presentation of data, while more advanced than in early childhood, are still relatively simple and straightforward.

EXHIBIT 3 (Continued)

Teaching A Given Competency At Different Developmental Levels

[High School] The student council at Lincoln High School decides to conduct a survey to find out what students want the council to do that year. The form it develops requests certain basic information (e.g., name, age, sex, grade) and asks several questions to elicit students' views. In addition, council members want to talk in depth with a few dozen students. The faculty advisor suggests that, instead of just talking to the people they know best, they do a random sample to determine which students to interview. One senior math class is studying basic sampling, and the council members present the sampling problem to the math class and get its help. Council members, asked about the purpose of the in-depth interviews, respond that they want to know the views of the student body as a whole—males and females at all grades. To achieve a representative group of interviewees, it is decided to divide the forms into piles by sex within each grade and to draw from each pile the forms of four students and one alternate. When the survey is completed, the council members compile the responses, work with computer graphics to find a clear and compelling way of conveying the results, and then use the graphics in making an oral presentation to the student body about the directions the student council will be taking in the coming year.

What's Developed in This Activity

- Further practice with developing forms that are efficient and readily understandable.
- Increased awareness of the purpose of sampling in real-life situations—achieving representativeness without having to survey every individual—and practice applying simple sampling concepts and procedures to a specific need.
- Facility in using computer graphics for presenting data and evaluating which methods best serve the purpose.

Developmental Considerations

- Students' foundation in math and earlier experiences with creating forms and surveys prepare them to take the additional step of working with sampling.
- Having had a range of previous experiences with creating and interpreting charts of different kinds and considering which suit various purposes, students can now begin doing the same thing with computer graphics. If they had had little experience with charts, it would be premature to have them producing charts using computer graphics technology.
- By this point in their development, students are able to take greater responsibility in their learning and extracurricular activities, often determining their own agenda and problems, identifying needed resources, and making their own choices and decisions.

Curriculum and Instruction in the Five SCANS Competencies

For each of the five competency areas (resources, information, interpersonal, systems, and technology), the following sections will describe the key dimensions of each domain, the concepts underlying these dimensions, and the knowledge/skill requirements at the career-ready level. Examples of educational innovation within each domain are offered to stimulate the thinking of teachers, principals, and curriculum developers. At the end of each section, references and key resources for each competency area are listed. At the end of the paper, additional readings and resources are provided to help schools get started in finding their own ways to achieve the goals of SCANS.

RESOURCES

We allocate resources in many of our daily activities, such as when we develop a monthly household budget or schedule the diverse activities of family members. Allocating resources—time, money, people, and materials—is also important on the job. The following pages provide details for educators interested in producing curricula to develop skills in allocating resources. This section analyzes key dimensions of the SCANS resource skills, explores how these important skills are used in today's workplace, and considers how to introduce them to students.

Key Dimensions of the SCANS Resource Skills

The skills needed to allocate resources have been defined in Exhibit 1. To give educators a more complete idea of what is involved in allocating resources, this section considers the key dimensions of each skill.

The first skill involves allocating time. The dimensions involved in performing this skill competently include:

- identifying tasks to be completed;
- ranking tasks in order of importance;
- estimating key task variables such as task importance, time to complete tasks, time available for task completion, and task deadlines;
- developing and following an effective, workable schedule based upon these estimations;
- avoiding wasting time; and
- evaluating and adjusting a schedule.

The second skill involves allocating money. In order to perform this skill effectively, an individual needs to be proficient at:

- preparing and using a budget according to a consistent and orderly accounting method;
- projecting costs and revenues;
- calculating future budgetary needs based upon these projections;
- tracking the extent to which actual costs and revenues differ from the estimated budget; and
- taking appropriate and effective actions to adjust the budget.

Allocating material and facility resources is the third skill. The key dimensions underlying performance of this skill include:

- planning the steps involved in the acquisition, storage, and distribution of resources, including space;
- safely and efficiently acquiring, transporting, or storing resources;
- maintaining them in good condition; and
- distributing them to the end user.

Completing the set of resource skills is allocating human resources. Effective human resource allocation requires:

- assessing peoples' knowledge, skills, abilities, and potential;
- identifying present and future workload characteristics and needs;
- making effective matches between individual talents and workload requirements;
- actively monitoring performance; and
- providing feedback.

By acquiring competence at allocating resources, students are learning to perform some of the basic functions of management—**planning**, **organizing**, and **controlling**. Each resources skill, to varying degrees, involves these three functions.

The importance of these three functions, beginning with **planning**, is illustrated in an example from the workplace. A pool of secretaries at a mid-sized accounting firm must deal with the increased workload and changing priorities of work during tax season, from January through at least April of each year. The lead secretary, Pat Munroe, sets aside some time one morning to assess the work that must be completed over the next several months, including ongoing projects and yearly tax returns. An influx of work is forecast during February and March, as accountants conduct the tax work necessary for the secretaries' preparation of tax forms. The goal of the secretaries' efforts is to complete tax or extension forms by April 15 without falling behind on other secretarial duties. Pat also projects what materials and forms will be needed to meet the increasing work demands and what personnel will be necessary to complete the work.

Pat's planning supports the next management function, **organizing**. At this point, action plans are developed to accomplish the work and achieve the specified goals. Pat and the other staff secretaries now have the task of developing work schedules that reflect both short- and long-term deadlines. They set priorities for tasks according to importance and estimate the time needed and available to complete each tax return. Anticipating that several accountants will fall behind schedule, Pat develops a contingency work plan.

Finally, Pat compares the group's progress with the anticipated goals at weekly intervals by asking questions: Would it meet its time deadlines? Was it completing all of its work, including client activities unrelated to taxes? Was the remaining supply of forms and materials adequate for projected needs? Were enough personnel available to complete the work in a timely manner? This facet of management, **controlling**, is concerned with monitoring, assessing, evaluating, and adjusting behaviors and activities to better meet identified needs or goals. While monitoring work activities, Pat determines that, at the present pace, meeting the April 15 deadline is not likely. Additional staff are allocated to the task, based upon their experience with tax form preparation and their ability to work under pressure.

We have explored the key dimensions of allocating time and materials as well as basic management functions associated with them. The example from the accounting firm shows that these functions and skill dimensions play an important role in the workplace. But how highly developed do an individual's resource allocation skills need to be upon graduating from secondary school? The next section provides a preliminary answer to this question.

What It Takes to Be Ready For Work

The job tasks below are "real life" examples generated from interviews with experts from a wide variety of jobs.* By exploring the skills needed to perform in actual work settings, educators can become familiar with the proficiency in resource allocation that students need to develop in order to successfully enter the workplace.

A quality control inspector allocates time and space when establishing a system for inspecting elevators in a given area within a given time frame. This includes organizing required inspections based on their due dates and establishing a geographical route that facilitates the best use of time for inspections. In order to perform these tasks effectively, the inspector is likely to:

- chart inspection due dates and geographical location of inspection sites (e.g., prepare a timeline or other chart);
- estimate the time needed and available to conduct an inspection and possible contingencies (e.g., travel time, conflicts, and time needed to schedule inspections); and
- generate a schedule of inspections that makes the best use of time and space by grouping key inspections in the same general geographical area.

A chef is required to allocate money when performing a cost analysis on menu items in order to turn a profit. This involves calling purveyors and searching for the freshest products and assessing the costs for various elements of preparation. To allocate money as required in this task, the chef must:

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*Details of these and additional work tasks are included in *Skills and Tasks for Jobs, A SCANS Report for AMERICA 2000,* 1992.

- identify, search for, and collect information concerning the freshness and costs available of meats and produce;
- assess or project customer demand for the product; and
- estimate costs, such as for labor and ingredients, garnishes, cooking weight loss, and revenues (e.g., by using a computer spreadsheet program).

A travel agent is required to allocate material and facility resources when acquiring and storing travel materials (e.g., brochures, catalogs, and forms) for subsequent distribution to customers. This includes finding a storage space for travel materials, ordering and storing materials in a consistent manner, retrieving materials as needed, and distributing them to clients. Performing these tasks effectively requires the travel agent to:

- identify client needs and collect relevant materials;
- plan the most effective layout for storing the materials to ensure easy access (i.e., group by travel service providers such as tourist information centers, airlines, hotels, and rental car agencies);
- store materials according to the chosen layout; and
- take an inventory of the materials and acquire additional materials when necessary.

An assistant housekeeper is required to allocate human resources when scheduling employees in productive working groups. This involves determining who is available to work at a given time, pairing the inexperienced workers with more experienced colleagues, placing the appropriate employees in work time slots, and logging the names of unavailable employees for future reference. To perform these tasks effectively, the assistant housekeeper must be able to:

- forecast staffing needs;
- conduct a performance appraisal; and
- draw up a staffing plan, pairing experienced with inexperienced staff.

The work activities described in this section are presented to assist educators in understanding workplace needs and helping students acquire the knowledge they need in order to allocate resources when they begin their careers. The following section describes some of the ways in which the resource skills are presently being introduced to students.

Developing Resource Skills in the Classroom Today

Resource skills traditionally have been introduced in courses, such as life skills and personal management, available primarily to vocational education students. Several recent educational initiatives afford all students the opportunity to develop and practice these important

skills in realistic contexts. This section presents a sampling of courses and activities occurring both within and outside of vocational education.

The New York State Education Department has produced a curriculum module on personal resource management to develop a student's knowledge and skill in the management of time, and human and economic resources. In a time management activity, for example, students analyze case studies involving effective time management and the development, use, and evaluation of a weekly time/activity schedule. To develop skill at managing human resources, they analyze case studies illustrating successful management of human resources, and they participate in small group brainstorming sessions on how members of a given group contribute individually to the success or failure of the group. The management of economic resources includes student performance objectives dealing with achievement of financial goals and understanding and preparing a personal budget.

Personal and family financial planning is a natural way to introduce students to the SCANS skill of allocating money. The Association of Teacher Educators (ATE) and the American Council of Life Insurance (ACLI) have published a guide to financial planning education for educators. Included in the guide are sample learning activities related to allocating money, such as learning the steps in planning a budget, discussing the similarities and differences between a family and a government budget, and collecting forms and guides useful in setting up a budget.

The Interactive Mathematics Project is a three-year pilot project in which students learn mathematics by solving a variety of real-world problems. The structure of the Interactive Mathematics Project enables students to gain expertise in SCANS resource skills. In a unit entitled "The Overland Trail," students study the issues faced by those who migrated westward during the mid-1800s. They apply mathematical concepts when deciding what to take during the move, estimating the cost of the move, studying rates of consumption and travel, and estimating the time required to reach the destination.

In a time management activity in the National Academy Foundation curriculum, students analyze how they spend their time and suggest strategies to maximize the use of time. Among the activities used to develop the concept of time management are: (1) student-created "Who am I?" collages to stimulate discussions of how they spend their time; (2) use of a calendar to plot individual schedules; and (3) introduction of a brainstorming activity to generate ways to use time more effectively. Homework includes identifying the major tasks faced by the student in the next two months and generation of a list of major personal time wasters.

Charles Jett, a partner with a Chicago-based executive search firm, has designed a program to provide high school students with classroom and practical exposure to critical skills, including time management. These skills are then practiced by student groups who provide consulting services to local organizations and businesses.

Time management skills are introduced to students in a Project Management module which includes: techniques useful to time management such as Gantt and Pert charts, scheduling multiple projects with time conflicts, and managing deadlines. Students construct a simple work plan during a classroom activity that explores managing time. Students also are expected to

construct a Gantt Chart to schedule normal high school activities and to be able to revise the chart in response to changing events and priorities. By providing consulting services to the business community, students are able to practice their newly acquired skills, for instance, by developing a project work plan illustrated by a Gantt chart.

An example of developing resource allocation skills at the elementary level is found in Caloosa Elementary School in Cape Coral, Florida. Students participate in classroom stores, a postal system, a restaurant, TV station, employment agency, publishing company, government, and bank in which they practice a variety of resource skills. Skills in allocating money, for instance, are developed in the Caloosa Bank. Students regularly deposit and maintain "Caloosa money" in savings or checking accounts, which enables them to develop a sense of responsibility in managing money and decide how much money to allocate, for instance, to the purchase of goods at the Caloosa store.

In the entrepreneurship class at Mount Edgecumbe High School in Sitka, Alaska, students operate a company that produces and exports smoked salmon to Japan. They must make a variety of resource-related decisions regarding the production and shipment of smoked salmon to customers. In addition, students in the high school's business course gain expertise at allocating money by using spreadsheets to map the costs associated with their planned life style after graduation.

The examples presented here are only a small sample of the educational activities that are happening around the country. Curriculum specialists, teachers, and principals have a great deal of work ahead of them as they seek to transform curricula and instructional strategies to reflect the SCANS goals of preparing students to allocate resources in today's workplaces. The programs and resources discussed in this section are highlighted below. Additional resources that may be valuable in getting started are provided at the end of this paper.

References and Resources

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Financial Planning Education: A Challenge for Teachers, Trainers, and Institutions (1982). Washington, D.C.: The Association of Teacher Educators.

Working Citizen Personal Resource Management. Introduction to Occupations (1986). Albany, NY: New York State Education Department, Division of Occupation Education Programs. This document describes instructional strategies for teaching personal management skills (time management, human resource management, and financial management).

Resources

A Community Within Academic Walls, Caloosa Elementary School

The Caloosa Elementary School has established a series of experiences that provide students with real world environments to practice classroom learning. Students may display their skills by working in or using the school's postal system, restaurant, employment agency, bank, and publishing company, among other experiences. For more information, contact: Carolyn Zenoniani, Principal, Caloosa Elementary School, 620 South Del Prado Boulevard, Cape Coral, Florida 33904, (813) 574-3113.

The Critical Skills Project

The Critical Skills project operates through the Wheaton, Illinois school system in cooperation with local businesses and Charles Jett, a management consultant. The program allows students to practice skills in local area businesses and to apply what they have learned in classroom problem solving exercises. For more information, contact: Charles C. Jett, 1113 North Irving, Wheaton, IL 60187, (708) 653-3433 (home) or (708) 682-5388 (office), FAX (708) 260-1912.

Interactive Mathematics Project

The Interactive Mathematics Project (IMP) is a three-year pilot project to develop and test an innovative high school mathematics curriculum. The IMP is a joint venture of the University of California at Berkeley and San Francisco State University that enables students to learn mathematics within the context of real world problems. The IMP curriculum is currently being tested in selected classrooms and is not readily available for general use. For additional information, contact: Mary Jo Cittadino, Network Coordinator, EQUALS, Lawrence Hall of Science, University of California, Berkeley, CA 94720, (510) 642-1823.

Mount Edgecumbe High School

Students at Mount Edgecumbe High School are exposed to a number of SCANS competency areas. In the school's entrepreneurship class, they make a variety of resource-related decisions while producing and shipping smoked salmon to customers in Japan. For more information, contact: Larrae Rochelau, Mount Edgecumbe High School, 1330 Seward Avenue, Sitka, AK 99835, (907) 966-2201.

National Academy Foundation Programs

The National Academy Foundation (NAF) is a collaborative effort between schools and businesses to prepare and motivate local youth for careers in several economic sectors (Finance, Travel and Tourism, Manufacturing Science, Public Service). For more information, contact: Bernadette Toomey, National Academy Foundation, 1155 Connecticut Avenue, N.W., Tenth Floor, Washington, D.C. 20036, (202) 296-7132, FAX (202) 296-9342.

INFORMATION

In today's "information society," people of all ages find, use, evaluate, and communicate many kinds of information every day. We use information to solve problems, make decisions, and carry out even the simplest daily activities, such as using a TV schedule, looking for the weather forecast, or using the telephone book.

In the past, schools have seen as a major part of their job the conveying of information to students. Though it is still important for students to acquire certain information, it is becoming more and more important for them to acquire the skills of finding, evaluating, compiling, packaging, and communicating information.

In order to help educators develop the curricula and means to teach such information skills, we begin by examining the key dimensions of these skills. Next, we look at the information skills needed for various jobs. Finally, we offer examples of learning activities and curricula from schools of today that seem to represent promising approaches to helping students acquire information skills.

Key Dimensions of the SCANS Information Skills

Exhibit 1 listed and defined the four information skills identified by SCANS. This section describes the key dimensions of each information skill to assist educators in developing curricula and introducing these vital skills to students.

A central information skill is acquiring and evaluating information. In order to acquire and evaluate information proficiently, the individual must be skilled at:

- analyzing questions to determine information needed;
- selecting and evaluating information; and
- determining when new information must be created.

A separate but related skill is organizing and maintaining information, for instance, setting up and keeping up-to-date files or a data base. Effectively performing this skill requires:

- understanding and organizing information from computer, visual, oral, and physical sources in readily accessible formats, (e.g., computerized data bases, spreadsheets, microfiche, video disks, paper files); and
- transforming data in order to organize it (e.g., by sorting, classifying, or more formal methods).

Interpreting and communicating information to others is another highly critical skill in the workplace. Competent performance of this skill requires expertise at:

- determining information to be communicated;
- identifying the best methods to present information, (e.g., overheads, handouts);
- choosing the best format for display, (e.g., line graphs, bar graphs, tables, pie charts, narrative);
- converting information to the desired format; and
- conveying information to others through a variety of means (e.g., oral presentation, written communication).

Finally, SCANS includes as a distinct skill, using computers to process information. Though clearly requiring and relating to the three previous skills, using computers to process information demands computer-specific skills as well. These include:

- entering, modifying, retrieving, storing, and verifying data and other information;
- choosing the best format for display (e.g., line graphs, bar graphs, tables, pie charts, narrative); and
- ensuring the accurate conversion of information into the chosen format.

In acquiring information, recognizing the **structure** of a document or database is fundamental; to retrieve information efficiently and accurately, individuals need to be able to find the underlying structure in lists, schedules, tables, indexes, and other documents and use this structure in retrieval (e.g., Mosenthal and Kirsch, 1989). Likewise, they need to develop the ability to organize information according to its logical structure as they display or communicate information—whether graphically, orally, in writing, or through other representational forms.

In the workplace, information is acquired, evaluated, and communicated for specific purposes. It is important to be able to adjust one's search for and processing of information to the **purpose** at hand. To take a simple example, a person should read an article differently if the purpose is to find a particular fact than if the intent is to become familiar with the main issues addressed. Reading the same way regardless of purpose wastes a great deal of time and effort. Similarly, purpose should also guide the way information is presented.

What It Takes to Be Ready for Work

As a part of the SCANS field research effort, descriptions of actual work tasks were collected from job holders and supervisors to illustrate how workers apply SCANS competencies and foundation skills on the job. Several of these illustrative tasks that emphasize information skills and related activities are presented in the following section. These actual work-setting examples provide insight into the information skills students need when they initially enter the workplace.

A telemarketing representative acquires and evaluates information from customers in order to meet their service-related needs. This includes asking about their needs or obtaining other service-related information from the customer, accessing and obtaining a computer-generated profile of customer information, and evaluating the accuracy of the information and its appropriateness to specific needs. Elements of information skills implicit in this description include:

- collecting data from a telephone survey;
- keeping records;
- using a computer;
- making an oral presentation;
- developing forms to collect data;
- setting up and using data base files; and
- interpreting and evaluating information.

A blue collar worker supervisor organizes and maintains purchase and cost-related information (e.g., purchase requests, invoices, raw materials cost data). This involves preparing written purchase requests or telephoning requests to vendors and recording order information. In addition, the blue collar worker supervisor receives materials and invoices, verifies the product received with the invoice entry, and maintains inventory records of all materials received and used. The activities involved include:

- developing forms and collecting data;
- finding information on forms;
- communicating exact information over the telephone; and
- organizing and maintaining records.

A dental hygienist communicates information about a patient's condition to a variety of individuals including doctor, patient, family members, and insurance companies. The hygienist checks the patient's dental charts and health records to determine overall patient condition, reads radiograms, and completes patient's insurance forms when requested. Information uncovered is communicated to the appropriate audience (e.g., dentist, patient, patient's family members, insurance agents). Performing this task involves:

- acquiring and evaluating data and information;
- developing forms and keeping data;

- organizing and maintaining files;
- communicating information;
- interpreting charts and information; and
- writing a description of events.

A travel agent uses on-line computer terminals to provide a variety of customer services (e.g., retrieve customer request information, plan itineraries, book airline tickets). Elements of information skills implicit in this description include:

- using an on-line computer data base to access information;
- selecting and evaluating information;
- interpreting information for the customer;
- communicating alternative choices for the customer; and
- ensuring the accurate conversion of information into the chosen format (e.g., hotel and airline tickets).

As these examples indicate, workers use a variety of information skills to perform successfully even the most routine work activities. How are these necessary skills being introduced to students today? The following section offers educators an introductory guide to useful educational programs and instructional activities.

Developing Information Skills in the Classroom

Traditionally, teachers have given students projects and assignments that involve acquiring, evaluating, organizing, interpreting, and communicating information. In language arts, for example, students do general research, practice library skills, and use reference materials such as dictionaries or encyclopedias. They learn how to differentiate trivial from important information and how to present information in writing projects, like term papers, and in oral presentations of various kinds.

While students are currently getting some exposure to basic information acquisition and management strategies in core academic courses, most schools are far from providing the necessary range of information-related experiences that students need to be ready for the workplace. Exhibit 3 (in the introduction to this paper) illustrated how this might be done at each of three grade levels. We will also take a look at some specific programs and instructional strategies developed around the country to provide students with opportunities to develop and refine their skills at managing information.

An important aspect of information skills as specified by SCANS is **document literacy**—the use of lists, diagrams, charts, and graphs to acquire, display and represent information. In a series

of articles entitled "Understanding Documents," Irwin Kirsch and Peter Mosenthal explore learning to organize, maintain, interpret, and communicate graphic information. They suggest activities designed to help students understand the basic structure of forms, tables, charts, and graphs as well as how to construct and abstract information from them.

Students studying the extent of arms sales to third world countries, for example, may be asked to study a line graph displaying relevant information and represent the information in a variety of ways, such as by developing a list of information, pie charts, and bar charts. Students may also participate in a discussion of the advantages and disadvantages of each method as well as of the different types and combinations of information needed to create graphs, charts, and lists.

The Michigan Department of Education Vocational-Technical Education Service's Employability Skills Learning Activities Guide grounds information skills in workplace examples. In a lesson on the use of labor market information data, for instance, students use library resources, guest speakers, organizational job charts, the Dictionary of Occupational Titles, computers, and many other information sources to chart a career in a chosen occupation. The students are evaluated on how well they can identify various sources of labor market information, describe social and economic factors that have an impact on the labor market, and determine career advancement opportunities.

Determining what information to use is difficult for many students, as shown by the results of the National Assessment of Educational Progress (1991) in mathematics. Many students had adequate skills in mathematics and still did poorly on non-routine word problems in which, for instance, extraneous information was given and they had to figure out what to use. Such findings have fueled a movement to bring more real world problems into math instruction. As Marilyn Burns (1992) indicates, the information needed to solve real world problems is rarely found in tidy packages. Rather, solving real problems requires data collection, often from a variety of sources.

What Burns and other math educators suggest is giving students experience with problems for which the information available is not a tidy package but more of an untidy heap—to sort through and determine what to use and how. Using this approach, teachers give students problems such as taking a pile of travel brochures, hotel advertisements, airline information, and other sources of information and determining the best possible vacation for a family of four. It is up to the students to figure out what information they need, where and how to find it among the available materials, and where to go to get additional information if necessary.

Computer technology is a powerful tool in developing information skills. At Alaska's Mount Edgecumbe High School, most computer learning activities focus on using the computer as a tool for achieving a goal. Students learn about graphics packages, spreadsheets, word processing, and other software. They use graphics to organize and present information, employ word processing packages to record homework assignments on the computer, and use statistical software packages to track their own academic productivity.

Commercially available educational software packages can be a useful tool for developing students' information skills. For instance, the National Geographic Society's (NGS) science curriculum—Kids Network—allows elementary school students to practice acquiring, evaluating,

interpreting, and communicating information through firsthand exploration of socially significant scientific themes, such as acid rain, solar energy, and the environmental impact of trash.

At Foothill Middle School in Walnut Creek, California—one of many schools that have participated in the NGS Kids Network—fifth, sixth, and seventh grade science students collected data on acid rain levels in local water supplies. The students worked in teams to decide how to collect the data and determine their accuracy and used computers to record and communicate data. Their data, along with those from participating classrooms across the nation, were electronically transferred to a centralized location where Kids Network staff organized individual classroom and group data and sent them back to participating classrooms via computer. Receiving this feedback, students could compare their class's findings with those of research teams in other classes. In Kids Network, students communicate findings and discuss issues with participating peers across the nation.

Database programs are especially valuable for developing students' information skills. Databases that are useful for teaching a variety of subjects, such as geography, history, and social studies, are available to interested educators. The World Geography Database, for instance, provides 51 fields of information on 80 countries (e.g., population, life expectancy by gender, percent of school attendance). A sample lesson requires students to use the database to explore problems created by conflicting cultures. Students determine information needs, collect and evaluate information in order to answer questions and solve problems, and identify additional information needs and sources when necessary.

A growing number of schools nationwide have recognized the importance of information skills and have attempted to teach students how to use computers to acquire, evaluate, organize, interpret, and present information in a practical, hands-on manner. Additional details and references are listed below and at the end of this paper.

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Resources

Foothill Middle School

Foothill Middle School is one of many educational institutions that have used the National Geographic Society's Kids Network curriculum. Science students at the middle school have used the Kids Network to conduct research on the extent of acid rain in their local water supply. For additional information, contact: Foothill Middle School, 2775 Cedro Lane, Walnut Creek, CA 94598.

Michigan Employability Skills Learning Guide

The Michigan Employability Skills Learning Guide includes performance/behavior indicators and learning activities for key employability skills. For more information, contact: Paul Stemmer, Ph.D., Michigan Educational Assessment Program, Michigan Department of Education, Office of Technical Assistance and Evaluation, Box 30008, Lansing, MI 48909, (517) 373-8393.

Mount Edgecumbe High School

Students at Mount Edgecumbe High School are exposed to a number of SCANS competency areas, for instance, in the school's entrepreneurship class where they make a variety of resource-related decisions while producing and shipping smoked salmon to customers in Japan. For more information, contact: Larrae Rochelau, Mount Edgecumbe High School, 1330 Seward Avenue, Sitka, AK 99835, (907) 966-2201.

National Geographic Society's (NGS) Kids Network

Students have the opportunity to explore socially relevant scientific topics with the NGS Kids Network educational software curriculum. Students using the Kids Network curriculum conduct research, use a computer to record data, and communicate findings on a variety of topics (e.g., prevalence of acid rain in local water supplies, environmental impact of trash). This curriculum was developed for NGS by Technical Education Research Centers (TERC). For additional information, contact: Dr. Candace Julyan, (617) 547-0430.

World Geography Database

The World Geography Database provides information on 80 countries (e.g., population characteristics, life expectancy, percent of school attendance) and is used by students to solve a variety of problems. For details on the World Geography Project and materials, contact Dr. Carlyn Elder, 3911 Mill Creek Drive, Annandale, VA 22003.

INTERPERSONAL

Training in interpersonal skills is now quite common. In Training Magazine's 1991 annual survey of employee training in the U.S., 64 percent of companies with 100 or more employees were found to provide interpersonal skills training. More specifically, 69 percent of those providing interpersonal skills training offered leadership training, 61 percent team building, 59 percent training in listening skills, and 53 percent problem solving.

At work, at home, at play—we continually interact with other people. From birth on, children interact with family members and playmates. Later they have other opportunities for interaction in sports and extracurricular activities. While most parents and educators intuitively recognize the importance of interpersonal skills in succeeding in work and life, the development of these skills typically has not been included in the academic curriculum. Even in extracurricular activities, the full potential for developing interpersonal skills is often lost because no one helps students see what is happening, for instance, what is keeping the group from making progress or helping group members work together effectively. In both the academic curriculum and extracurricular activities, increasing students' awareness and development of interpersonal skills is seen by SCANS as essential to preparing them to succeed in the workplace.

Key Dimensions of the SCANS Interpersonal Skills

SCANS defined the necessary interpersonal skills in Exhibit 1. Breaking down each skill into its key dimensions is the first step in considering what needs to be in the curriculum.

One of the primary interpersonal skills involves participating as a member of a team. In order to be a successful team member, individuals must skillfully:

- share tasks necessary to complete a project;
- encourage each other by listening and responding appropriately to contributions;
- recognize and build on individual strengths;
- resolve differences for the benefit of the group as a whole;
- take personal responsibility for accomplishing goals; and
- responsibly challenge existing procedures, policies, or authorities.

Certain interpersonal skills, such as listening and responding appropriately to others' contributions, are applicable in dealing with any person on any team. Teamwork skills are further enhanced by learning how to recognize and understand others' styles of working and communicating, to accommodate cultural differences, and to draw on each team member's strengths.

Teaching others is another key interpersonal skill. Successfully teaching others, whether one-on-one, in small groups, or large gatherings, requires a worker to:

- help others to apply concepts and theories through coaching or other means;
- recognize training needs;
- convey job information in a way that allows others to see its applicability and relevance to tasks; and
- assess performance and provide constructive feedback/reinforcement.

Serving clients/customers is a highly critical skill as workers interact with customers, co-workers, and other key staff. Competent performance requires a worker to:

- listen actively to identify needs and avoid misunderstandings;
- communicate in a positive manner especially when handling complaints or conflicts; and
- be familiar with relevant resources to satisfy customer needs.

The importance of good customer service cannot be overestimated. Research shows that a typical dissatisfied customer tells at least ten other people about poor service. Companies that hire service people are likely to pay a great deal of attention to applicants who demonstrate good customer service skills.

Exercising leadership is also important. Competent leaders are able to:

- make positive use of the rules/values followed by others;
- justify a position logically and appropriately;
- establish credibility through competence and integrity; and
- take minority viewpoints into consideration.

While no clear consensus exists among experts on the specific skills that make for good leadership, the skills most often cited fall into three broad categories: **diagnostic** (e.g., problem-solving, and critical and creative thinking), **perceptual** (e.g., communication through good verbal and listening skills), and **behavioral** (e.g., teamwork, team building, negotiation, delegation, motivation and coaching/counseling). Knowing which leadership style to use will depend on (1) the context of the situation or organization where leadership is required, and (2) the individual's level of mastery in each of the skill categories listed above.

Workers must also be skillful at negotiating to arrive at a decision, which requires them to:

- research the opposition and the history of a conflict;
- set realistic and attainable goals;
- present facts and arguments objectively;
- listen to, hear, and reflect on what has been said;
- clarify problems, when necessary, and resolve conflicts;
- adjust quickly to new facts/ideas;
- propose and examine possible options; and
- make reasonable compromises.

Finally, working with cultural diversity, requires:

- understanding one's own culture and those of others and how they differ;
- respecting the rights of others while helping them make needed adjustments in their behavior at work;
- make judgments and decisions on the basis of performance, not stereotypes; and
- understand the concerns of members of other ethnic and gender groups.

Underlying the various skills listed above, one finds a number of common themes. A fundamental one is **awareness of the interpersonal dimension** of situations in the workplace. In a meeting, for instance, a worker may have knowledge and proficiency in all the "impersonal" aspects of the task at hand, and yet be unaware of the interpersonal dimension, including the differing personalities and agendas of the other participants and their relationships with one another. This lack of awareness is likely to limit the individual's effectiveness in the meeting and may even cause problems for the overall functioning of the group. A prerequisite to all the interpersonal skills, awareness of interpersonal dynamics, is a necessity for effective workplace functioning.

Besides varying in awareness of interpersonal dynamics, workers differ in what may be termed **perspective taking**, that is, the degree to which they recognize and take into account the perspective of other people. Perspective taking is essential to most of the interpersonal skills identified by SCANS. In order to teach or train effectively, for instance, one must be able to put oneself in the place of the less experienced individual and make appropriate judgments about the content and method of the training that will suit the learner's needs. Successful negotiation also requires being able to recognize and take into account the needs, motivations, and perspective of the other party. Serving a customer or client, working with other team members, showing

sensitivity to a co-worker of a different race, cultural group or gender—to do any of these successfully requires recognizing and taking into account the perspective of another person, which may differ substantially from one's own.

Frequently cited as important in dealing with others in the workplace, **flexibility** is another common thread among the various interpersonal skills. Clearly, rigidity is not conducive to good teamwork; each worker must modify his or her own individual preferences, priorities, and work style in order to work smoothly with others. Effective leadership requires flexible, creative thinking. In successful negotiation, too, one needs to be able to adjust to new information or ideas, devise new options and approaches, and make reasonable compromises.

Underlying most of the interpersonal skills are two other abilities, **problem solving** and **communication**. Problem solving, which requires analyzing an interpersonal situation, coming up with a range of solutions, and evaluating these, is critical in serving customers, participating as a team member, negotiating, and exercising leadership. Moreover, research confirms what we all see around us: proficiency in interpersonal problem solving does not necessarily go along with proficiency in solving impersonal problems. One can be an excellent troubleshooter of computer technology, for instance, and be poor at understanding and resolving problems with one's co-workers—smart, but not "people smart." Since individuals do not automatically develop interpersonal problem-solving skills from having experience with other kinds of problem solving, educators need to ensure that students have plenty of experience with interpersonal situations, especially of the kinds they will encounter in the workplace.

As for communication skills, it is difficult to imagine a worker being effective in meeting the interpersonal demands of the workplace without being proficient in communication skills, including attentive listening and the ability to convey information, feedback, and opinion in clear and positive terms. Although interpersonal skills are further developed, extended, and honed through workplace experiences, there is a level that is necessary for the performance of jobs at the beginning levels of work, as described in the next section.

What It Takes to Be Ready for Work

Below are several illustrative tasks providing real examples of how interpersonal skills are used in the workplace. They are based on the SCANS field research, which included interviews with incumbent workers.

A plastic molding machine operator works as a member of a team on a production floor in order to identify problems and ensure that everyone works at a consistent speed. In order to perform this task effectively, the machine operator is likely to:

- coordinate activities and movements with other group members to optimize production;
- communicate needs to group members;
- listen and respond to needs of group members; and

- identify, discuss, and resolve problems through cooperative group efforts.

An accounting/financial analyst must teach new co-workers office procedures; for instance, how to send bi-monthly memos. This includes explaining the necessary contents of the memo and observing and providing feedback on the new worker's performance. To teach the co-worker how to develop and send these memos, the accounting/financial analyst must:

- explain and/or model desired task-related behaviors;
- convey job information in a way that allows the co-worker to see its applicability;
- monitor performance and provide feedback to help the co-worker effectively apply related concepts to the task;
- establish credibility through competence and integrity; and
- recognize and build on the co-worker's individual learning style and strengths.

A customer service representative assists customers by responding to their needs, including selecting merchandise, processing merchandise returns, responding to a customer's request for specific merchandise, resolving complaints, and receiving payment for merchandise in either cash or credit form. Performing this task effectively requires the customer service representative to:

- actively listen to customers to understand their needs, avoid misunderstandings, and clarify problems;
- communicate in a positive manner;
- resolve conflicts and complaints by evaluating and selecting the most appropriate option; and
- understand how to acquire additional resources to serve the customer, when necessary (e.g., communicate with the supervisor, obtain manufacturer information for the customer).

A graphics designer displays leadership by convincing others that change and evolution are not only necessary but desirable. The designer does this by considering different ways of reaching a goal, and then convincing the client to be open to new concepts. Finally, the designer motivates clients, staff, and vendors to do the best job possible. These activities require the graphics designer to:

- successfully promote new concepts to clients;
- reinforce credibility and competence of staff and organization to client; and
- motivate staff to perform satisfactorily to meet customer's new needs.

A telemarketing representative *negotiates* with customers to close a sale by demonstrating how particular products meet the customers' needs and showing the advantages of the company's products over those of competitors. The representative listens and responds to customer resistance and allows customers to overcome previous resistance without losing face. To perform this job, the telemarketing representative must:

- present facts and arguments objectively to justify marketing the product;
- adjust quickly to new facts/ideas presented by the customer; and
- communicate effectively by listening and responding appropriately.

An offset lithographic press operator works with cultural diversity by making sure that expertise and not ethnicity is the determining factor for a work assignment. This includes determining what kind of expertise is needed to perform a job and who has the best qualifications, and asking the most qualified person to perform the job. The press operator must be able to:

- understand the cultural differences among individuals from different ethnic groups;
- base action taken on performance, not stereotypes or personal preferences;
- establish credibility by performing the job with integrity; and
- make positive use of rules.

The next section takes a brief look at some of the educational experiences that are being offered to help students acquire such interpersonal skills during their years in school.

Developing Interpersonal Skills in the Classroom

The National Academy Foundation (NAF) curriculum has a wide range of activities to foster interpersonal skills needed in the world of work. For example, the following activity promotes an understanding of how groups work and gives students experience in teaching others. Students learn why organizations have their own set of rules and regulations and the need to follow these regulations in order to succeed.

Students are divided into groups, and each group of students invents a game and attempts to write clear and understandable rules. A student from each team is appointed to observe the group process and, using a "process observer sheet," notes various behaviors, such as how the group reaches decisions. When the time is up, one speaker from each group explains the game rules to the class, and the class evaluates these for clarity. On the following day, the process observers report to the class the behaviors observed for each group. The observer's comments help to focus each team member's understanding on how his or her behavior affected other group members and the work of the group as a whole.

The New Haven Social Development Program, developed by Roger Weissberg and his colleagues, is a 27-lesson program for use with sixth graders (eight other programs developed by

Weissberg and colleagues are available). Though they originally emerged from a preventive mental health initiative rather than an educational one, they are for classroom use and aim to promote the interpersonal problem-solving skills identified by SCANS. Participating elementary students from suburban and inner-city families have been found to learn interpersonal problem-solving skills that generalize to real-life situations outside the classroom.

Using small-group role plays, videotape modeling, cartoon workbooks, class discussion, and other methods, the programs teach a six-step model that gives students a basic framework for interpersonal problem solving. At the same time, Weissberg and others working in the area have found that students also need a certain amount of "domain-specific" problem-solving experience in order to become effective problem solvers in a given domain. These findings underline the need for workplace scenarios that help students develop the specific interpersonal problem-solving skills they will need in those settings.

NAF provides a variety of "domain-specific" experiences in a program, designed to prepare students for careers in travel and tourism. The following activity was developed as a training exercise by the operations division of a major hotel chain. Students break up into groups and role-play in different situations involving dissatisfied customers, with one person in each group playing a complaining customer and one playing a hotel manager. At the end of the role play, each group reports its solutions, and the class asks follow-up questions and evaluates the solution. Students develop skills in giving and receiving feedback (constructive criticism), and they learn the importance of providing good customer service without diminishing the dignity of individual employees.

Role-playing can be taken to a further stage of elaboration in extended simulations that provide a wide range of opportunities to develop interpersonal skills and other SCANS competencies. Simulations of companies, with students as the officers, are used in the 7th grade at Orange Grove Middle School in Tucson, Arizona to give students experience in group problem solving and decision-making, negotiating, and other interpersonal skills (see Systems, the following section, for a detailed example of a simulation).

Among the tools that schools find useful in promoting interpersonal skills are educational software simulations marketed for classroom use. An example is Our Town Meeting, a simulation of local government intended for use in social studies in grades 5-12. It is designed to be used on one computer with as many as 15 students. Players act as representatives of three agencies engaged in completing projects to benefit an imaginary town. They face dilemmas that mimic the kinds of decisions made in a real community. Students learn about the relative merits of competition versus collaboration among agencies. The program uses the computer as a tool to take care of record-keeping and to coordinate work. "Agencies" take turns at the computer, where they receive information about the proposed project in the form of voter polls, cost estimates, and forecasts of revenue gains. When away from the computer, each group prepares speeches and decides how much money to request during a hearing with the mayor (the teacher). In addition to gaining an increased understanding of the issues confronting a growing community, the students get experience in negotiation and compromise.

SCANS emphasizes having students work together in groups or teams on all sorts of projects and problems, with the twofold aim of getting students more actively involved in their

own learning and fostering the interpersonal skills and teamwork that are so important in the workplace. This idea is by no means unique to SCANS. Cooperative learning and team/small group formats have been investigated heavily in the past two decades and found to be effective in boosting achievement, motivating students, and raising their self-esteem (e.g., Slavin, Leavey, and Madden, 1984; Johnson and Johnson, 1975). The positive effects of cooperative learning methods on relationships across racial and ethnic lines and between students at very different levels of academic achievement are also well-documented. Teachers and schools interested in making more extensive use of student groups and teams can readily find information and assistance from the resources at the end of this section as well as those at the end of this paper.

References and Resources

References

Johnson, D., & Johnson, R. (1975). Learning Together and Alone. Englewood Cliffs, NJ: Prentice-Hall.

Slavin, R., Leavey, M., & Madden, N. (1984). Combining Cooperative Learning and Individualized Instruction: Effects on Student Mathematics Achievement, Attitudes, and Behaviors. Elementary School Journal, 84, 409-422.

Resources

National Academy Foundation Programs

The National Academy Foundation (NAF) is a collaborative effort between schools and businesses to prepare and motivate local youth for careers in several economic sectors (finance, travel and tourism, manufacturing science, public service). For more information, contact: Bernadette Toomey, National Academy Foundation, 1155 Connecticut Avenue, N.W., Tenth Floor, Washington, D.C. 20036, (202) 296-7132, FAX (202) 296-9342.

New Haven Social Development Program

The New Haven Social Development Program is designed to provide elementary school students with the opportunity to apply interpersonal problem-solving skills in a variety of situations. Information on this and other related training programs and materials is available from Dr. Roger Weissberg. Prior to July 1, 1992, Dr. Weissberg can be reached at Yale University, (203) 432-4530. After July 1, 1992, he can be reached at: Department of Psychology, (M/C) 285, 1009 Behavioral Sciences Building, The University of Illinois at Chicago, Box 4348, Chicago, IL 60680

Orange Grove Middle School

The Systems Thinking Project is a three-year venture focusing on classroom teachers and whole school systems. For additional information, including models and simulations developed at the Orange Grove Middle School, contact: Frank Draper, The Systems Thinking Project,

Catalina Foothills School District, Orange Grove Middle School, 1911 E. Orange Grove Road, Tucson, AZ 85718. (602) 575-1234.

Our Town Meeting

Our Town Meeting is a computer simulation designed to promote group cooperative learning. Up to 15 students participate in a simulation of a local government. They role-play various positions within the town and make important real-world decisions as part of an exercise in collaborative group problem solving. This simulation package is available from Tom Snyder Productions, 90 Sherman Street, Cambridge, MA 02140; (800) 342-0236.

SYSTEMS

We encounter systems in the home, the workplace, the media, and throughout our daily lives. Understanding systems makes it easier to understand how many processes in the world take place. SCANS has determined that, in addition to understanding systems, tomorrow's workers need to monitor and correct performance in a system and improve or design systems (see Exhibit 1).

This section is written for educators interested in developing systems skills: understanding systems, monitoring and correcting performance, and improving or designing systems. We first consider the key dimensions and underlying concepts for each skill and show how the skills are used in work settings. We next provide examples of systems learning occurring today in some schools.

Key Dimensions of the SCANS Systems Skills

Each of the SCANS systems skills has at least two key dimensions. A more detailed discussion of these dimensions may be useful as a first step in developing curricula.

The first skill, understanding systems, involves basic knowledge of:

- social, organizational, and technological systems; and
- how to operate effectively within them.

Although the SCANS definition of understanding focuses on systems—social, organizational, and technological—that are especially prominent in the workplace, there are many other natural and man-made systems, such as biological, physical, political, and economic ones. From kindergarten on, there will be many opportunities to introduce students to systems. Moreover, developing knowledge of different kinds of systems should help to inculcate the habit of "systems thinking," as discussed below.

To operate effectively in an organization, the worker must know how an organization's structures relate to its goals, which people to ask for information or resources, how to respond to the demands of the organization, and how to function within its formal or informal codes.

The second systems skill, monitoring and correcting performance, has four dimensions:

- distinguishing trends;
- predicting impacts on system operations;
- diagnosing deviations in systems' performance; and
- correcting malfunctions.

The first dimension rests on the SCANS foundation skills of reading, listening, and seeing things in the mind's eye. The last three dimensions—predicting, diagnosing, and correcting—call for **application**. To make predictions and diagnose deviations in a system's performance, one must already have knowledge of how the system works.

The third skill, improving or designing systems, has two dimensions:

- suggesting modifications to existing systems; and
- developing new or alternative systems to improve performance.

Improving or designing systems involves making suggestions, recommending alternative system designs, and, sometimes, responsibly challenging the status quo. In many situations, good oral and written communication skills, part of the SCANS foundation, are necessary for effectively presenting system improvements.

Finally, improving or designing systems requires **synthesis**, insightful combination of previously acquired forms of knowledge. People who can improve or design systems are likely to have in-depth understanding of several similar systems. They generally have experienced many and varied situations that required monitoring and correcting a system's performance. And above all, they are likely to have had multiple opportunities to try to improve or design a real system.

Systems Thinking

The existing discipline of systems thinking, also known as systems theory or system dynamics, is:

> a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static "snapshots." It is a set of general principles—distilled over the course of the twentieth century, spanning fields as diverse as the physical and social sciences, engineering, and management. It is also a set of specific tools and techniques, originating in two threads: in "feedback" concepts of cybernetics and in "servo-mechanism" engineering theory dating back to the nineteenth century (Senge, 1990, pp. 68-69).

From this perspective, to understand systems is to understand dynamic (changing) relationships, to see circular patterns of cause and effect, and to identify hidden, interacting, or multiple causes of observed events and behaviors. Complexity, circular causality, and multiple causality are the hallmark of many natural and man-made systems, some of which are already studied in elementary, intermediate, or high schools, as discussed below in Developing Systems Competence in the Classroom. Moreover, the underlying concepts of systems thinking—its "tools"—are useful in the workplace.

Senge (1990) describes a mythical electronics company called WonderTech that began with meteoric growth: sales doubled in the first three years. But sales declined in the fourth

year, increased in the fifth, declined again in the sixth, and so on. Eventually, the company slid into bankruptcy. The dynamic system that lay at the root of the company's problems was as follows: When revenues increased, the sales force was increased, and orders went up. However, when orders went up, a backlog arose and delivery times increased. The long delivery times, after a delay, led to sales difficulty and, eventually, a decreasing number of orders. The WonderTech example illustrates five of the most important underlying concepts of systems thinking:

1. Dynamic complexity. A defining characteristic of a system, dynamic complexity, exists when an obvious, apparently logical action (stepping up advertising) produces a nonobvious consequence (decreased orders), often in another, more distant part of the system.

2. Stocks and flows. A stock is something that accumulates in a system (e.g., orders). Flows act to increase or decrease the stock (e.g., advertising and salespersons affect orders, as do backlogs).

3. Reinforcing processes and positive feedback loops. A reinforcing process is operating when change builds on itself (e.g., orders beget more orders). When the change is positive (increasing number of orders), a positive feedback loop exists.

4. Balancing processes and negative feedback loops. A balancing process is operating when a process (backlog) acts to slow or counter the effects of another process. When the effect is negative (decreasing orders), a negative feedback loop exists.

5. Delay. Decreasing orders did not follow immediately from the increasing backlog, as there were intervening steps—increased delivery time and sales difficulty.

WonderTech's managers reacted to the decrease in orders by stepping up advertising and sales efforts, which made matters worse by increasing the number of orders. If they **understood** this organizational system (the skill of understanding), they might have **predicted** the impact of their decisions and **diagnosed** the company's problem sooner (the skill of monitoring and correcting). Then they might have taken steps to **improve** delivery time (the skill of improving or designing). To explore this example in greater depth, see Senge (1990).

What It Takes to Be Ready for Work

Another way to look at systems skills is to consider what it takes to be ready for work. Below are descriptions of actual work tasks illustrating the three systems skills. These examples confirm the importance of the systems skills and dimensions for some common occupations. They carry, in addition, implications about some specific skills that high school graduates would do well to acquire.

A medical assistant working in a clinic must understand the system of the organization and know how to operate effectively within it. The assistant needs to:

- understand the organization's ultimate goal (i.e., excellent patient care);

- maintain knowledge of the clinic's organization, including the organizational chart;
- keep up with changes;
- respond to demands of the system when assignment changes occur;
- keep current on which departments in the system handle what specialties; and
- learn which resources outside of the clinic offer patient services.

Implicit in these requirements is a complex organization that continually changes staff assignments and the responsibilities of different departments. To facilitate both initial learning at job-entry and later keeping track of the changes, it would be most helpful if the high school graduate knew how to draw and interpret an organizational chart.

A travel agent must monitor and correct performance to ensure that all customers are well served in a timely manner. Activities at a typical travel agency include:

- monitoring the performance of other travel agents as well as oneself to ensure that all customers are served in a timely manner;
- suggesting alternative routes to complete itineraries;
- correcting one's own mistakes, as well as those of other agents; and
- contacting customers to inform them of any mistakes or changes in travel.

This description indicates that the travel agent needs to develop an effective monitoring process. This could take different forms, such as surveying customers or periodically reviewing a sample of itineraries. In addition, understanding and tracking trends in travel preferences, costs, and options improve the agent's effectiveness.

A traffic, shipping, and receiving clerk may be required to improve or design a system. For example, this job involves:

- determining more efficient ways to stack merchandise;
- observing the processes involved in loading, unloading, and moving merchandise;
- developing ideas for performing these activities more efficiently; and
- sharing the ideas with the supervisor, and implementing changes which ultimately save money or prevent damage to merchandise.

Useful suggestions, as this description implies, often have their origins in careful observation of existing processes. After developing an idea for improving the system, the worker

needs to be able to communicate it clearly to others. The ability to draw a diagram that represents the improved system is likely to be helpful.

Developing Systems Competence in the Classroom

Learning the underlying concepts of systems thinking holds much promise. Systems thinking can be taught in several ways. First, teachers might attempt to make systems concepts more explicit in subject matter they are already teaching. For instance, when teaching seventh grade students about the U.S.-Soviet arms race, a history teacher might use a diagram to point out the positive feedback loop, stocks and flows, and delay. This would not only acquaint students with systems concepts but also convey the critical feature of circular causality: the build-up of nuclear weapons in the U.S.S.R. led to a build-up in the U.S., which eventually led to further increases in Soviet arms, and so on.

Classroom projects can be developed to simultaneously instruct systems thinking and disciplinary content at the intermediate or high school level (e.g., biology). For example, the Pre-College Education Project at the Massachusetts Institute of Technology (MIT) has developed a project that teaches the dynamics of epidemics—how the number of people infected grows over time (Glass, 1991).

To start, students shake hands with other students, allowing them to become infected with New England Regional Disease (NERD). After data on the number of infections are collected, students work cooperatively to formulate hypotheses and make graphic representations of projected outcomes. It turns out that the number of infections increases in an S-shaped manner (relatively slow, then increasing, then slowing again) because: (1) the infection rate increases as the number of infected people increases (a reinforcing process), but (2) the healthy population decreases as more people become infected (a balancing process). Later, students use computers and special software to build several different models of epidemics. The software allows manipulation of stocks, flows, and other system elements.

In the above example, systems concepts are made intellectually explicit. Students are actively engaged in thinking about a biological phenomenon, and they learn cooperatively from each other. If systems concepts in biology are linked to those in other academic subjects, students have a framework that can give new meaning and cohesion to their educational experiences.

Some schools go a step further and link systems projects to the world of work. These innovative schools have developed integrated simulations that help students to develop and simultaneously use a range of foundation skills and all five of the SCANS competencies—systems, resources, interpersonal, information, and technology. At the Orange Grove Middle School in Tucson, Arizona teachers of different subjects within a grade share the same planning period, and classes are scheduled in blocks, so students can carry out these integrated simulations (their term is "systems projects").

In one integrated simulation, seventh grade students are divided into six companies that mine and sell aluminum and copper. They have just completed a two-month study of geology in science and a study of fractions in math. The officers of each company must decide which mines to lease and which to keep in production (drawing on knowledge of geology). They also decide

how to allocate operating capital to production, public relations, marketing, pollution control, and R & D (drawing on math skills, including fractions). Supply, demand, and prices for the two metals vary in a systematic way with the decisions of each company, which is networked with the other companies through a file server.

Frank Draper, a teacher at Orange Grove Middle School, describes a second systems project called the New State Park as follows:

> Students had to research park philosophy, park management, land management, recreation theory, social systems, geography, ecological community theory, and politics. They then used their newly acquired knowledge to design a new park with a $100,000,000 budget. The park had to include land required by the park's charter, yet deal effectively with a threatened lawsuit if they desecrated nearby Indian burial sites; be attractive to users, yet not cause appreciable environmental degradation. As the students designed the park on a computer, they used a spreadsheet to keep fiscal accountability and a [systems] model of park development/environmental degradation to keep design accountability (1989, p. 3).

The last two examples are most in tune with the SCANS vision of the schools of tomorrow. However, the other approaches offer alternatives for schools where resources and opportunities for restructuring are presently limited.

The Orange Grove Middle School is one of perhaps several hundred schools in Arizona, California, Vermont, Massachusetts, and other states that are attempting to teach systems skills. A hopeful sign is the recent establishment of an exchange to coordinate and disseminate school-based systems integration projects, the Creative Learning Exchange. Programs and resources specifically discussed in this section are listed below; other resources are provided at the end of this paper.

References and Resources

References

Draper, F. (1989). Letter to Dr. Jay Forrester, dated May 2. Available from Frank Draper, Orange Grove Middle School, 1911 E. Orange Grove Road, Tucson, AZ 85718.

Glass, W. (1991). Teaching System Dynamics: Looking at Epidemics. Available from William Glass, Pre-College Education Project, Massachusetts Institute of Technology, System Dynamics Group, E40-294, 1 Amherst Street, Cambridge, MA 02139.

Senge, P. (1990). The Fifth Discipline: The Art and Practice of the Learning Organization. New York: Doubleday.

Resources

Creative Learning Exchange

The Creative Learning Exchange is a database and information exchange dedicated to coordinating and disseminating systems thinking applications to educators throughout the country. For additional information contact: Lee Stuntz, Director, Creative Learning Exchange, 1 Keefe Road, Acton, MA 01720. (508) 287-0070.

Orange Grove Middle School: Systems Thinking Project

The Systems Thinking Project is a three-year venture focusing on classroom teachers and whole school systems. For additional information, including models and simulations developed at the Orange Grove Middle School, contact: Frank Draper, The Systems Thinking Project, Catalina Foothills School District, Orange Grove Middle School, 1911 E. Orange Grove Road, Tucson, AZ 85718. (602) 575-1243. FAX (602) 577-5307.

Systems Dynamics Group/Pre-College Education Project

The Pre-College Education Project is developing systems-based classroom projects with applicable software to assist teachers and students in making education more meaningful. For additional information contact: Nan Lux, Systems Dynamics Group, 77 Massachusetts Avenue, Massachusetts Institute of Technology, E40-294 MIT, Cambridge, MA 02139; (617) 253-1574. FAX (617) 253-6466.

TECHNOLOGY

Both our economic well-being and the quality of our lives depend, to a significant degree, on an ability to understand and use technology—computers, machines, and other tools. The SCANS definition of technological competence requires: developing the ability to **understand** computers, machines, and other tools and to **use** them to solve problems. The definition includes three component skills: selecting technology, applying technology, and maintaining or troubleshooting technology (see Exhibit 1). This section explores key dimensions of these skills, their use in work settings, and some educational trends and teaching approaches that support their development.

Key Dimensions of the SCANS Technology Skills

The first skill is selecting technology. It involves judging which set of procedures, tools, or machines, including computers and their programs, will produce the desired results. Among the dimensions of this skill are:

- determining desired outcomes and applicable constraints;
- visualizing the necessary methods and applicable technology; and
- evaluating specifications.

Selecting appropriate technology to fit the situation is a form of problem solving. The desired outcomes and applicable constraints define the problem, while the solution is the procedure, machine, or tool chosen to get the job done. Typically, a worker arrives at a solution via a thinking process that may include evaluation of machine specifications, visualization of methods and applicable technology, or both. This kind of technological problem solving depends on experience with particular computers, programs, machines, tools, or procedures.

The second technology skill, applying technology to tasks, involves using computers and other kinds of equipment to achieve the desired results. It is demonstrated by a person who:

- understands how different parts of machines interact and how machines interact with broader production systems;
- installs machines, including computers;
- sets up machines or systems of machines efficiently to get desired results;
- accurately interprets machine output; and
- detects errors from program output.

The first dimension is most important because it implies understanding of the overall intent, or purpose of the technology. Without this understanding, installation, set-up, and

interpretation of output are apt to be faulty. The last dimension is similar to the SCANS skill of diagnosing deviations in the performance of a system.

The third skill, maintaining and troubleshooting technology, involves preventing, identifying, or solving problems in machines, computers, and other technology. It includes:

- identifying, understanding, and performing routine preventative maintenance and service on technology;
- detecting more serious problems;
- generating workable solutions to correct deviations; and
- recognizing when to get additional help.

In the past, technical skills were taught to young people who enrolled in vocational education courses because they were not bound for a four-year college. In today's rapidly changing workplace, technology education is essential for all students regardless of where they are bound after high school and it is the responsibility of all educators. Technology education can take a variety of forms, as discussed later in Developing Technology Skills in the Classroom.

What It Takes to Be Ready for Work

One way to answer the question "What needs to be taught?" is to ask "What does it take to be ready for work?" Below are descriptions of actual work tasks illustrating the level of technology skills that all high school graduates may be reasonably expected to attain.

A graphics designer must select technology, determining which tools could best accomplish the work required to meet the goals of a project. Among the activities to be performed are:

- reviewing the customer's ideas (e.g, by reading a description of project requirements);
- evaluating the graphic methods or tools to be used (e.g., by reading technical specifications);
- choosing a particular tool or method to produce rough drafts;
- using this tool or method to produce rough drafts; and
- looking at rough drafts and alternate methods to decide which is the best technology for the customer's project.

At the heart of these activities is the ability to read a requirements description and technical specifications and come up with a match. In essence, the graphic designer is engaging in technological problem solving.

A hotel account executive/sales executive applies technology nearly every day by:

- using a computer to check reservations;
- using a computer to reserve the required number of rooms and assign room numbers to an incoming group;
- activating a direct computer link to a credit bureau to qualify new customers;
- using the word processing function of a computer for correspondence and memos; and
- using a computer to check the occupancy rate for a monthly sales meeting (e.g., from a spreadsheet).

The first activity above requires knowledge of the hotel's computerized reservations system. For all of the activities, the account executive needs to be able to read and follow the instructions in various software manuals; clearly, the foundation skill of reading is important. The task description also points to the value of prior educational experiences that have involved word processing technology.

A food service manager maintains and troubleshoots technology in these ways:

- performing preventive maintenance on a dishwasher, ensuring that the equipment is cleaned, sanitized, and properly reassembled each week;
- locating the source of problems and starting repairs; and
- knowing when he or she is incapable of fixing the problem and when to contact a maintenance specialist.

In this work setting it is important to understand and follow written maintenance and repair instructions, since relying on outside help would be costly and cause delays in the operation. The ability to understand these instructions depends, in turn, on reading skills and understanding how parts of the machine interact (part of the skill of applying technology).

Developing Technology Skills in the Classroom

The SCANS agenda for developing technology skills is supported by two important trends in K-12 education: the changing nature of technology education itself, and the integration or "infusion" of technology in elementary and secondary classrooms. This section describes examples and approaches that will be useful for educators to think about as they consider how to increase students' technology competence.

The Changing Nature of Technology Education

Modern technology includes information and communications technology, and manufacturing technology, biotechnology, and space technology, to name a few areas. Oaks and Pedras (1992) describe the changes in technology education as follows:

> Several years ago we [technology educators] called our area of study industrial arts. It was characterized by drafting machines, wood lathes, and table saws. Construction of tool boxes, bird houses, and bookshelves were a mainstay of the field. Today, technology education is the appropriate name, and computer-aided drafting, computer-aided manufacturing, laser photography, and robotics are fundamental. We spend more time with silicon chips than we do with wood chips (p. 11).

The shift from "wood chips to silicon chips" occurred in two phases. In the first phase, an emphasis was placed on students learning about computers and other new information technology. In the emerging second phase, students are learning to use computers in technological problem-solving and design activities. Examples of a technological problem-solving activity and a design activity follow; both involve computers.

In the Fort Worth Independent School District in Texas, students work with sophisticated equipment to solve technological problems. For example, they create, through a problem-solving process, a computer-aided manufacturing loop that activates a robot to load a piece on a conveyor belt, unloads the piece with a pneumatic device after it passes an electric eye that tells the computer it is ready to be unloaded, takes the piece to a machine to be drilled, and finally returns the piece to the robot. (See the following paper for more information on Fort Worth.)

Design activities begin with a "real life" problem that demands goal-directed technological creativity. For instance, students at Lakeland Regional High School in Wanaque, New Jersey engaged in a two-year project to design a replica of a 19th century water wheel for a nearby historical park. After researching the historical background of the wheel, water wheels as a source of power, and methods of constructing water wheels, students made drawings and templates, designed pieces using computer graphics, selected suitable materials, tested pieces, and eventually built a full-size working replica of the wheel (LoCascio, 1990).

In addition to these changes in scope and content, technology education is becoming an integral part of the total school curriculum for all students. As one indication of this change, the State of New York requires every student to complete a one-unit course by the end of eighth grade, Introduction to Technology. The course develops technological problem-solving skills through learning activities each lasting several weeks. In one activity, students explore the nature, function, and control of rocket systems and subsystems. Model rockets are built and tested, and adjustments made to optimize flight performance.

Coherent sequences of courses called Tech Prep curricula are being developed to link two years of postsecondary technical education with a systematic course of study in high school—either all four years or the last two years ("4 + 2" or "2 + 2"). The purpose of Tech Prep curricula is

to provide the technical foundation needed by the "neglected majority" of students. These students need postsecondary technical education to remain competitive in the workplace, though they may not be pursuing a four-year college degree. Until recently, many of these students took courses indiscriminately. With no career goal in mind, they simply accumulated enough credits to graduate. Later, they entered technical or trade schools with inadequate backgrounds in math, science, technology, communications, or business.

Some of the courses that have been developed for Tech Prep students are also appropriate for students who are preparing to attend four-year colleges. For example, Principles of Technology is an award-winning laboratory-based course in applied physics. Its aim is to produce technically literate students with a solid understanding of physics concepts in mechanical, fluid, electrical, and thermal energy systems. These concepts include: force, work, rate, resistance, energy, power, force transformers, momentum, waves and vibrations, energy convertors, transducers, radiation, light and optical systems, and time constants. Principles of Technology is accepted as a pre-college laboratory course by MIT and Georgia Tech.

Richmond County, located on the coastal plain of North Carolina, has developed a successful 4 + 2 program with a strong core of academic and vocational/technical courses. Academic courses include Algebra I, Geometry, and regular or precollege English; vocational/technical courses include Principles of Technology, Electronics, Technical Health Occupations, and Computerized Accounting I & II. In the fall of 1986, 25 percent of Richmond County students were enrolled in precollege and 75 percent in general/vocational studies. By the fall of 1990, only 37 percent of the students were enrolled in general/vocational studies; the balance were in precollege (32 percent) or Tech Prep (31 percent). The percentage of students enrolling in Algebra I rose from 47 percent in 1986 to 75 percent in 1990. SAT scores of graduating seniors increased 47 points over the same period, while the dropout rate decreased (James, 1991).

The Leander High School in Austin, Texas has articulated an exemplary 2 + 2 Tech Prep program with Austin Community College (ACC). To prepare students for entry into an advanced technology course of study at ACC, Instrumentation and Control Technology, students take these courses in their junior and senior years: Principles of Technology I & II, Algebra or Geometry, Semiconductors, Technical Graphics, Using Personal Computers, and Electricity, DC and AC (Tech Prep, 1988).

Integrating Technology

Merely increasing students' access to computers and multimedia tools such as videocameras, videodisks, scanners, and sound digitizers may help to improve their technological competence. However, the idea that students simply need exposure to technology has been replaced with one of much greater power: the view that students need to be given opportunities to use and think *with* technology. The project manager for Apple Classrooms of Tomorrow, Dr. David Dwyer, has expressed it this way:

> When we think about classrooms we think of them as places where kids are active players, engaged in inquiry into problems that are meaningful and relevant to them. We see teachers as facilitators in this process—collaborators in knowledge-building activities,

architects of learning contexts in which children pursue challenging tasks over meaningful amounts of time, inspired and encouraged by their mentors and coaches (1991, p.4).

A second powerful idea in integrating technology is the view that technology can serve as a catalyst for integrating different subjects and skills. At the Marin School for Integrated Studies, an experimental high-tech program for high school students in San Anselmo, California, the aim is to show that all disciplines are integrated in the real world. In a typical project, teams of students studied the problems of drought in Marin County from a variety of angles. In English class they read Dune, a science fiction novel featuring society's reaction to lack of water. In biology they studied drought-resistant plants and used graphics software to diagram the plants' DNA. One team grew the plants in a garden they designed with special software. Other teams measured water usage in the area and surveyed residents' attitudes toward water conservation (Muson, 1992).

There are many ways to provide opportunities for students to use and think with technology. The best of these involve extended projects that teach not only technology skills but also other SCANS skills, such as information and interpersonal skills. A four-week technology/ community involvement program for high school seniors in Anoka, Minnesota is a good example (Images in Action). Student teams searched three comprehensive data bases for information needed to analyze such issues as preservation of wetlands and health care for the elderly. They discussed public policy related to these issues, and with the aid of computers, developed a paper including their recommendations supported with data, graphs, and maps they designed. The best papers were selected for formal presentation to the state legislature.

Additional examples of successful integration of technology in classrooms such as occurred in Anoka have been collected in Images in Action, a publication of the National Foundation for the Improvement of Education. The resources section at the end of this paper provides additional resources for the technology competency.

References and Resources

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Resources

Tech Prep Program: Richmond County, North Carolina

The Tech Prep program in Richmond County, North Carolina was designed to improve the technical skills of students not focused on pursuing four years of post-secondary education. This 4+2 program motivates high school students to focus on academic and career options earlier to enhance their mastery of mathematics, communication skills, science, and problem solving. For additional information contact: Myrtle D. Stogner, Director, NC Tech Prep Leadership Center, P.O. Box 1189, Hamlet, NC 28345; (919) 582-7187.

Fort Worth Independent School District

New high-technology labs are currently part of the curriculum at five high schools and four middle schools, and plans are under way to implement the program at all high schools and middle schools in the Fort Worth Independent School District. Students will explore applications in the areas of robotics and computer-aided manufacturing, and experiment with pneumatic structures, rocketry, and more. For additional information contact: Dr. David Greer, Program Director, Technology Education, FWISD, 3210 West Lancaster, Fort Worth, TX 76107; (817) 878-3737.

Apple Classrooms of Tomorrow (ACOT)

Apple Classrooms of Tomorrow is a research and development collaboration among public schools, universities, research agencies, and Apple Computer. Its purpose is to expand the role of technology in the classroom beyond the simplistic notion of computers as teaching machines to technology as a thinking tool. For additional information contact: David Dwyer, Project Manager, Apple Classrooms of Tomorrow, Apple Computer, Inc., 20525 Mariani Avenue, MS: 76-5E, Cupertino, CA 95014. (408) 974-4574 or 996-1010; FAX (408) 862-6430.

ADDITIONAL READINGS AND RESOURCES

This section offers additional readings and resources for individuals interested in further exploring the question of how to teach the SCANS competencies. First, we present suggested readings for each of the competency domains. Next, we provide an initial list of resources that includes existing educational programs and commercially available products. Contact information is provided when appropriate.

The Office of Personnel Management (OPM) offers a variety of courses to government employees that correspond to the SCANS competencies. Information on these and other courses can be found in the OPM Catalog, *Guide to Training and Development Services*, 1992 edition (document number 1991-296-050). To obtain this publication, contact: Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

As a final note, keep in mind that instructors of courses or training modules, often housed in community colleges or the training departments of local businesses, are a rich source of information concerning the content of curricula and instructional activities for each of these skills.

Additional Readings

Resources

(Time)

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Lakein, A. (1973). How to Get Control of Your Time and Your Life. New York: P. H. Wyden.

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Interpersonal

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Bennis, W., & Nanus, B. (1985). Leaders. New York: Harper & Row.

Byrnes, J. (1987). Creative Confrontations: The Art of Negotiating. Trainer's Workshop (pp. 11-64). New York: American Management Association.

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Green, E., Cook, P., & Rogers, J. (1984). The Need for Interpersonal Skills Training and Supervision. NASSP Bulletin [National Association for Secondary School Principals], 68 (467), 23-30.

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Technology

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Wright, J. (1991, March-April). Technology Education Laboratories of the 90's. TIES, 14-18.

Additional Resources

Resources

Human Resource Planning

This monthly periodical explores key human resource planning issues.

International Journal of Physical Distribution and Materials Management

This monthly periodical explores key issues related to managing materials.

International Time Management Institute, Pittsford, New York

The International Time Management Institute (ITMI) is committed to increasing personal and professional productivity and offers a variety of workshops and products to achieve this aim. For additional information, contact: International Time Management Institute, 3800 Monroe Avenue, Pittsford, NY 14534. (716) 383-6000.

Interpersonal

Building on Achievement

The "Building on Achievement" program, a cooperative project of the Bank of America (BofA) and Mission High School in San Francisco, starts with a "career awareness" module for sophomores. This module includes such topics as acceptable behavior in the workplace, appropriate dress, self-presentation and resume writing, interpersonal skills, and teamwork. For more information, contact Cindy Fisher or Arno Kracht, Bank of America, 1 South Van Ness Avenue, San Francisco, CA 94103. (415) 241-3214 (Cindy) or (415) 241-3221 (Arno).

John Hancock/English High School Partnership

In 1989 the John Hancock Mutual Life Insurance Company/English High School Partnership, began a Hancock On-Premises Education (HOPE) program to address a gap between students' skills and company requirements for various positions. English High selects 25 students to attend classes taught twice a week by instructors Hancock provides. Target skills, including communication skills, are embedded in realistic business problems. For more information, contact: Winston H. Richie, Jr., Senior Consultant, International Group Department, John Hancock Mutual Life Insurance Company, John Hancock Place, P.O. Box 111, Boston, MA, 02117. (617) 572-8670.

Systems

Students Vocational Trades Foundation, Montgomery County, Maryland

The Montgomery County Students Construction Trades Foundation (CTF) and Automotive Trades Foundation (ATF) are nonprofit foundations established by the Montgomery County business and professional community in cooperation with the Montgomery County Public Schools. Student learning is situated in whole, intact, functioning business systems; the ATF's Mini Dealership; and the CTF's "mini-construction firm." For more information, contact: Carolyn Darne, Montgomery County Students Vocational Trades Foundations, 12501 Dalewood Drive, Silver Spring, MD 20906. (301) 929-2190.

Technology

Youth Apprenticeship and Tech Prep, Arkansas Department of Education

The Arkansas Department of Education is one of many state education agencies that have been actively involved in school reform programs aimed at enhancing technology skills. Arkansas is providing for the implementation of five or more demonstration Youth Apprenticeship/Work-Based Learning projects based on a contextual or experiential model of learning. In addition, a new Tech Prep curriculum is being implemented in the state's high schools. It will consist of

courses in technology education (particularly computers), keyboarding, personal and family life skills, career/occupational orientation, applied academics, and workplace readiness. For more information, contact: Jean McEntire, Associate Director, Vocational and Technical Education Division, Arkansas Department of Education, 3 Capitol Mall, Luther S. Hardin Building, Little Rock, AR 72201. (501) 682-1040.

COMSAT/Jefferson Alliance

The Communications Satellite Corporation (COMSAT) in 1989 entered into a $1.1 million, 5-year alliance with neighboring Jefferson Junior High School of Washington, D.C. to establish a school of distinction in mathematics and science. The purpose—very much in tune with SCANS—is to place the learning of basic skills such as math computation and problem solving in the context of broader competencies and "real" technological problems. For more information, contact: Robert W. Hunter, Director of Corporate Communications, Communications Satellite Corporation (COMSAT), 950 L'Enfant Plaza, SW, Washington, DC, 20024. (202) 863-6000.

Technology, Innovation, & Entrepreneurship for Students (TIES)

TIES is a monthly magazine published by Drexel University, Philadelphia, PA. It is for teachers interested in helping students increase their technological literacy and capability. *TIES* provides teachers with up-to-date resources for the development of a hands-on, problem-solving technology education curriculum. For additional information, contact: Scott Anderson, (215) 895-1680.